

SATURDAY, AUGUST 7, 1880.

BIRD FURNITURE.

BY DR. J. B. HOLDER, ASST. SUPT. AM. MUSEUM.

It is fair to say that, hitherto, no serious effort has been directed toward the proper furnishing of museum cabinets. This is especially the case with reference to Ornithology. Excellent specimens, often rare, all most valuable, and many special pets, highly prized, are placed with such surroundings and accessories as to very much detract from the pleasing effect they are capable of producing. This is so patent that any intelligent observer must have noticed the incongruity, though the cause may not be clear to him.

This subject will bear a very much fuller consideration than we can now give it. We will, however, present the results of a deliberate and careful study of certain *desiderata* in this connection. The trustees of the American Museum of Natural History in Central Park, New York, in view of the great value and scientific importance of the Prince Maximilian collection of birds, owned by the museum, determined to have them mounted in a manner commensurate with their worth.

A large collection of skins of North American birds presented by Mr. Elliott, was also placed in the hands of the taxidermist. To be in keeping with the excellent work sure to come from Mr. Bell, the matter of

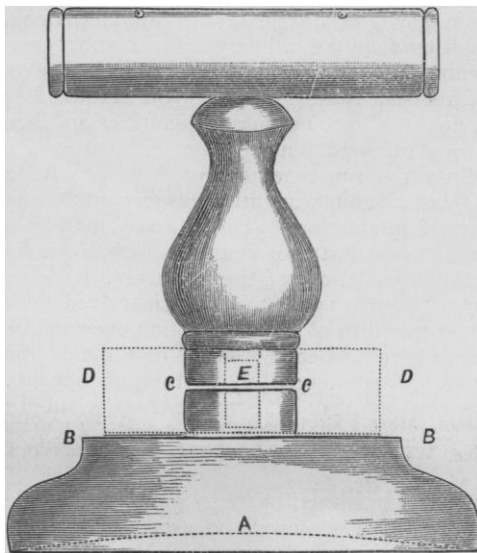


Fig. 1.

perches and stands became of the first importance. In large museums specimens are frequently moved to

allow of more varied views, or to give place to others near them: it is desirable to exhibit one bird facing, another sidewise, the next with its back in front; this involves a change or removal of label.

To simplify this, as the result of our experiments, we refer to the figure of the bird perch. The wood is of the plainest straight-grained mahogany, handsomely polished. Though somewhat more expensive, it is regarded economical to use such furniture, as in a large museum it is manifestly desirable to avoid any future overhauling, or what householders call "spring cleaning." The polished stands and perches only require the occasional use of a feather duster. Birds once mounted in this manner require nothing further, and remain intact for all time. The base of the perch is hollowed, as indicated by dotted lines at "A." This is to allow labels or written notes to be concealed safely beneath for reference.

The top of the base "B.B." is, practically, a tablet, upon which the label rests and rotates. The upright or column presents an appearance of completeness after the label is mounted; the bead just under which the label works forming the base, all below being out of sight.



Fig. 2.

"E" represents a bit of tin which embraces the label in front on its upper edge, and lies behind and in contact with it. A slender copper wire is passed around the tin, and is then compressed into the groove which surrounds the upright at "C.C." This wire is twisted behind the upright, and left projecting sufficiently to allow it to be held by the thumb-nail while rotating the label upon the tablet, "B.B." It will be readily seen that this movement is easily made, and constitutes the chief point of interest in the perch. We think also that the proportions of the perch, the manifest harmony of parts, the fitting relations of label and tablet, each designed for the other in due proportions, may be regarded as improvements more or less in advance of the old methods.

Another group of birds than those that perch require flat stands; as ducks, walking birds, etc.

Our second illustration exhibits a device, very simple, yet suitable. It is desirable to place the label upon the stand, so that it may be removed or its

locality changed readily. The block, as seen in the figure, has a bead on each edge; these beads are grooved to admit the label, which is of stiff parchment paper. The upper groove is deepest, so that the upper edge of the label may be pressed into it sufficiently to allow the lower edge to drop into the lower groove. It will be seen that we then have a label free to move, the entire periphery giving the utmost freedom for exhibiting every aspect of the specimen. Of course these blocks may be made with upright sides. Though the labels are more expensive for the bevelled ones, the latter have a more pleasing appearance.

COMPETITION BETWEEN THE ANILINE AND MADDER DYES.

BY A. S. MACRAE.

As these dyes are globularly used to the extent of some one hundred million dollars per annum; as they are as well known to the manufacturers of New England as to the horse-hide colorers of Japan, it may be interesting to inquire what effects, in *esse* and *posse* the one is having upon the other in commercial value. And as the market price invariably depends upon supply and demand, the source of the former must be examined into that the estimate of the latter may lead to judicious deductions.

Previous to the modern use of the above, indigo, cochineal, and the vegetable or wood dyes were altogether in vogue, and the inestimable appreciation of the indigo was primarily the cause which led to the discovery of aniline. The coloring matter of indigo has long been technically known as anil, and the manner in which it gave the name to aniline, has perhaps never been published before this present article. The botanist had ever been puzzled to know whence came the coloring matter of the indigo plant. Where it was indigenous the dyeing matter was inherent; but although the plant flourished almost anywhere in tropical climates, it invariably lost its color yielding power on this transportation! How was this? The botanist had to appeal to the chemist for explanation. Investigation demonstrated that the anil or coloring matter was solely due to the subsoil over which the indigo plant fructified, and that apart from this metaliferous or possibly bituminous earth, the coloring idiosyncrasy was lost. It will thus be seen that the article cannot be produced at will, but only where it and the soils are indigenous. However much this certainty baffled the botanist, it only set the chemist a-thinking. His analysis and synthesis showed beyond cavil, that anil, pure and simple, was neither more nor less than a hydro-carbonic compound, and that amongst some of these artificially produced compounds, anil, otherwise than the anil of indigo, might yet be discovered. The cheapest object for this research naturally suggested itself, and common coal-tar—the refuse of gas works—

presented itself as the most economic basis of naphtha, and the matrix of an abundant hydro-carbon. It would be irrelevant here to trace the success which crowned the chemists' efforts to produce anil, or as it was now called, aniline, from this once—but now no longer so—rejected filth. But one portion of the discovery must be referred to, not only in demonstrating the discoverers' wonderful patience, but as proof of the capricious supply of this marvellous product. Coal tar, then, yields naphtha; naphtha, benzole; benzole, nitro-benzole; nitro-benzole, aniline. When the naphtha was first distilled from coal tar, no benzole was discovered in it, or, if it was discovered, in such small quantities as to defy remunerative production. But the trace was there, and as most auriferous deposits are discovered by traces, these said traces were pursued until the golden goal was scientifically and successfully attained. When the naphtha was distilled by different temperatures, it was found that benzole was produced at one temperature that was smothered at another, and that by grading the distillations actual benzole could be eliminated in paying quantities! From this moment common coal-tar became the matrix of those valuable aniline dyes, which under the names of roseine, aniline reds and crimsons, Nicholson's blues, Humbolts, mauves, magentas, Bismark browns, oranges, iodine greens, purples, magdalias, violets, greens, phosphines, etc., have astonished the world for the last twenty years. Nearly all the dazzling colors worn now-a-days, that dim the sun and flaunt the eyes, are derived from the very cheapest of bases named, yet have arrived at such a value in the manipulation, that prices run from \$2 to \$30 a pound and in some cases even \$6 an ounce.

At the period of these discoveries, madder had largely superseded indigo, cochineal and other dyes, and at its producible price was certainly the most economic dyeing product extant. Madder is neither more nor less than the ordinary madder root ground, a root capable of cultivation to an unlimited extent. Turkey in Asia, Italy, France, Spain, Holland, and Naples produced it in enormous quantities and British India soon followed suit. The importations into Great Britain at one time amounted to 50,000 tons, and at least a similar quantity was consumed in the countries of production. Unknown as madder may be by that nomenclature, every housewife knows it under the appellation of the "Turkey Red," the name manufacturers gave to their prints dyed by this article. Some idea of its consumption even in America may be given, when it is stated that the writer of this article saw some 500 tons of this madder in the manufactory of A. & W. Sprague & Co., of Providence, R. I., when he visited those works a few years ago.

If then aniline is used by the *pound* where madder is used by the *ton*, it may well be asked by merchants, manufacturers and dyers, what will be the effect of the competition between them? the one the limited production of human manipulation, the other the unlimited production of cultivated nature. We will examine the question.

"Every dog has its day," and in the day of aniline

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We cannot now see, whatever we foresaw in bygone days, that madder and its derivatives, have anything at all to fear from aniline and its beautiful eliminates. As circumstances alter cases, so the position of the two chief dyes are equalized by the extent of the supply and the restrictions of demand. Aniline can not be produced *ad libitum*, madder can. Almost unlimited high prices will always be given for the former; but the latter, experience shows us for the first time, can be grown for almost unlimited low prices. The rich and the poor consumers can thus be well served; but madders go with the poor and therefore the popular prices of both may, nay they will, fluctuate as markets may dictate; but the fear that aniline will end in the supercession of madder is, we think, entirely groundless. The madder “day” is imminent, if not actual now-a-days, and wherever we go its “hues” are more prominent than those of its great competitors.

THE influence of magnetisation on the tenacity of iron has been lately studied by Signor Piazzoli. Iron wires were hung between two hooks and ruptured by pouring water into a vessel suspended from them. They were about 350 mm. long, and were inclosed in a spiral with four windings one over another, which were either all traversed by a current in one direction, or two by a current in one direction, and two by an equal opposite current, so that in both cases the wires were equally strongly heated by the spiral; but in one case they were magnetised, in the other not. The weights required to break wires annealed in charcoal—weight of one metre, $G = 0.299$ —were, during magnetisation, $P = 1260.1306$; without magnetisation, $P' = 1213.1270$. In the case of wires annealed in carbonic oxide—where $G = 0.46$ g.— $P = 1732.4.1742.7$; $P' = 1703.62.1719.87$. In the case of wires annealed in hydrogen $P = 1289.5.1310.1$; $P' = 1263.1299.7$. In each separate series accordingly the difference, $P - P'$ was frequently less than the difference between the highest and lowest weights required for rupture of apparently identical wires; still, the mean values in each of the fourteen series were from about 1 to 3 per cent greater for the magnetised than for the unmagnetised wires, showing that the tenacity of iron increases on magnetisation.

DEGENERATION.

BY ALFRED R. WALLACE.

Degeneration causes an organism to become more simple in structure, in adaptation to less varied and less complex conditions of life. “Any new set of conditions occurring to an animal which render its food and safety very easily attained, seem to lead as a rule to degeneration; just as an active healthy man degenerates when he becomes suddenly possessed of a fortune; or as Rome degenerated when possessed of the riches of the ancient world. The habit of the parasitism clearly acts upon animal organisation in this way. Let the parasitic life once be secured, and away go legs, jaws, eyes and ears; the active and highly-gifted crab, insect, or annellid may become a mere sac, absorbing nourishment and laying eggs.”

We see incipient cases of degeneration in the loss of limbs of the serpentiform lizards and the pisciform mammals; the loss of eyes in the inhabitants of caverns and in some earth-burrowers; the loss of wings in the Apterix and of toes in the horse; and, still more curious, the loss of the power of feeding themselves in some slave-holding ants. More pronounced cases are those of the barnacles—degenerated crustacea, and the mites—degenerate spiders; while we reach the climax of the process in Ascidians—degenerate vertebrates, and such mere living sacs as the parasitic Sacculina and Lernæocera, which are degenerated crustaceans. Not only such lesser groups as the above, but whole orders may be the result of degeneration. Such are the headless bivalve mollusca known as Lamellibranchs, which are believed to have degenerated from the head-bearing active cuttle-fish type; while the Polyzoa or Moss-polyps stand in the same relation to the higher Mollusca as do the Ascidiens to the higher Vertebrates.

While discarding the hypothesis that all savages are the descendants of more civilized races, Prof. Lankester yet admits the application of his principle to explain the condition of some of the most barbarous races—“such as the Fuegians, the Bushmen, and even the Australians. They exhibit evidence of being descended from ancestors more cultivated than themselves.” He even applies it to the higher races in intellectual matters, and asks: “Does the reason of the average man of civilized Europe stand out clearly as an evidence of progress when compared with that of the men of bygone ages? Are all the inventions and figments of human superstition and folly, the self-inflicted torturing of mind, the reiterated substitution of wrong for right, and of falsehood for truth, which disfigure our modern civilization—are these evidence of progress? In such respects we have at least reason to fear that we may be degenerate. It is possible for us—just as the Ascidian throws away its tail and its eyes and sinks into a quiescent state of inferiority—to reject the good gift of reason with which every child is born, and to degenerate into a contented life of material enjoyment accompanied by ignorance and superstition.”

This is very suggestive; but we may, I think, draw a yet higher and deeper teaching from the phenomena of degeneration. We seem to learn from it the absolute necessity of labor and effort, of struggle and difficulty, of discomfort and pain, as the condition of all progress, whether physical or mental, and that the lower the organism the more need there is of these ever-present stimuli, not only to effect progress, but to avoid retrogression. And if so, does not this afford us the nearest attainable solution of the great problem of the origin of evil? What we call evil is the *essential* condition of progress in the lower stages of the development of conscious organisms, and will only cease when the mind has become so thoroughly healthy, so well balanced, and so highly organized, that the happiness derived from mental activity, moral harmony, and the social affections, will itself be a sufficient stimulus to higher progress and to the attainment of a more perfect life.

For numerous instructive details connected with degenerated animals we refer our readers to the work itself—truly a small book on a great subject, and one which discusses matters of the deepest interest, alike to the naturalist and the philosopher.—*Nature*.

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We see incipient cases of degeneration in the loss of limbs of the serpentiform lizards and the pisciform mammals; the loss of eyes in the inhabitants of caverns and in some earth-burrowers; the loss of wings in the Apterix and of toes in the horse; and, still more curious, the loss of the power of feeding themselves in some slave-holding ants. More pronounced cases are those of the barnacles—degenerated crustacea, and the mites—degenerate spiders; while we reach the climax of the process in Ascidians—degenerate vertebrates, and such mere living sacs as the parasitic Sacculina and Lernæocera, which are degenerated crustaceans. Not only such lesser groups as the above, but whole orders may be the result of degeneration. Such are the headless bivalve mollusca known as Lamellibranchs, which are believed to have degenerated from the head-bearing active cuttle-fish type; while the Polyzoa or Moss-polyps stand in the same relation to the higher Mollusca as do the Ascidians to the higher Vertebrates.

While discarding the hypothesis that all savages are the descendants of more civilized races, Prof. Lankester yet admits the application of his principle to explain the condition of some of the most barbarous races—“such as the Fuegians, the Bushmen, and even the Australians. They exhibit evidence of being descended from ancestors more cultivated than themselves.” He even applies it to the higher races in intellectual matters, and asks: “Does the reason of the average man of civilized Europe stand out clearly as an evidence of progress when compared with that of the men of bygone ages? Are all the inventions and figments of human superstition and folly, the self-inflicted torturing of mind, the reiterated substitution of wrong for right, and of falsehood for truth, which disfigure our modern civilization—are these evidence of progress? In such respects we have at least reason to fear that we may be degenerate. It is possible for us—just as the Ascidian throws away its tail and its eyes and sinks into a quiescent state of inferiority—to reject the good gift of reason with which every child is born, and to degenerate into a contented life of material enjoyment accompanied by ignorance and superstition.”

This is very suggestive; but we may, I think, draw a yet higher and deeper teaching from the phenomena of degeneration. We seem to learn from it the absolute necessity of labor and effort, of struggle and difficulty, of discomfort and pain, as the condition of all progress, whether physical or mental, and that the lower the organism the more need there is of these ever-present stimuli, not only to effect progress, but to avoid retrogression. And if so, does not this afford us the nearest attainable solution of the great problem of the origin of evil? What we call evil is the *essential* condition of progress in the lower stages of the development of conscious organisms, and will only cease when the mind has become so thoroughly healthy, so well balanced, and so highly organized, that the happiness derived from mental activity, moral harmony, and the social affections, will itself be a sufficient stimulus to higher progress and to the attainment of a more perfect life.

For numerous instructive details connected with degenerated animals we refer our readers to the work itself—truly a small book on a great subject, and one which discusses matters of the deepest interest, alike to the naturalist and the philosopher.—*Nature*.

PHYSIOLOGY OF THE FRESH WATER MEDUSA.

The structure of this remarkable animal has already been investigated and described by Professors Allman and Lankester, with the result of showing that, although constituting a new genus, it is in all respects a true Medusa. After the publication of their papers I began to work out the physiology of the new form, and the following are the results which so far I have obtained.

The natural movements of the Medusa precisely resemble those of its marine congeners. More particularly, these movements resemble those of the marine species which do not swim continuously, but indulge in frequent pauses. In water at the temperature of that in the Victoria Lily-house (85° F.) the pauses are frequent, and the rate of the rhythm irregular—suddenly quickening and suddenly slowing even during the same bout, which has the effect of giving an almost intelligent appearance to the movements. This is especially the case with young specimens. In colder water (65° to 75°) the movements are more regular and sustained; so that, guided by the analogy furnished by my experiments on the marine forms, I infer that the temperature of the natural habitat of this Medusa cannot be so high as that of the water in the Victoria Lily-house. In water at that temperature the rate of the rhythm is enormously high, sometimes rising to three pulsations per second. But by progressively cooling the water, this rate may be progressively lowered, just as in the case of the marine species; and in water at 65° the maximum rate that I have observed is eighty pulsations per minute. As the temperature at which the greatest activity is displayed by the freshwater species is a temperature so high as to be fatal to all the marine species which I have observed, the effects of cooling are of course only parallel in the two cases when the effects of a series of high temperatures in the one case are compared with those of a series of lower temperatures in the other. Similarly, while a temperature of 70° is fatal to all the species of marine Medusæ which I have examined, it is only a temperature of 100 degrees that is fatal to the freshwater species. Lastly, while the marine species will endure any degree of cold without loss of life, such is not the case with the freshwater species. Marine Medusæ, after having been frozen solid, will, when gradually thawed out, again resume their swimming movements; but this freshwater Medusa is completely destroyed by freezing. Upon being thawed out, the animal is seen to have shrunk into a tiny ball, and it never again recovers either its life or its shape.

The animal seeks the sunlight. If one end of the tank is shaded, all the Medusæ congregate at the end which remains unshaded. Moreover, during the daytime they swim about at the surface of the water; but when the sun goes down they subside, and can no longer be seen. In all these habits they resemble many of the sea-water species. They are themselves non-luminous.

I have tried on about a dozen specimens the effect of excising the margin of the nectocalyx. In the case of all the specimens thus operated upon, the result was the same, and corresponded precisely with that which I have obtained in the case of marine species. That is to say, the operation produces immediate, total, and permanent paralysis of the nectocalyx, while the severed margin continues to pulsate for two or three days. The excitability of a nectocalyx thus mutilated persists for a day or two, and then gradually dies out—thus also resembling the case of the marine naked-eyed Medusæ. More particularly, this excitability resembles that of those marine species which sometimes respond to a single stimulation with two or three successive contractions.

A point of specially physiological interest may be here noticed. In its unmutated state the freshwater Medusa exhibits the power of localizing with its manubrium a seat of stimulation situated in the bell. That is to say, when a part of the bell is nipped with the forceps, or otherwise irritated, the free end of the manubrium is moved over and applied to the part irritated. So far, the movement of localization is precisely similar to that which I have previously described as occurring in *Tiaropsis indicans* (*Phil. Trans.*, vol. clxvii.) But further than this, I find a curious difference. For while in *T. indicans* these movements of localization continue unimpaired after the margin of the

bell has been removed, and will be ineffectually attempted even after the bell is almost entirely cut away from its connections with the manubrium; in the freshwater Medusa these movements of localization cease after the extreme margin of the bell has been removed. For some reason or another the integrity of the margin here seems to be necessary for exciting the manubrium to perform its movements of localization. It is clear that this reason must either be that the margin contains the nerve-centres which preside over these localizing movements of the manubrium, or much more probably, that it contains some peripheral nervous structures which are alone capable of transmitting to the manubrium a stimulus adequate to evoke the movements of localization. In its unmutated state this Medusa is at intervals perpetually applying the extremity of its manubrium to one part or another of the margin of the bell, the part of the margin touched always bending in to meet the approaching extremity of the manubrium. In some cases it can be seen that the object of this co-ordinated movement is to allow the extremity of the manubrium—i.e., the mouth of the animal—to pick off a small particle of food that has become entangled in the marginal tentacles. It is therefore not improbable that in *all* cases this is the object of such movements, although in most cases the particle which is caught by the tentacles is too small to be seen with the naked eye. As it is thus no doubt a matter of great importance in the economy of this Medusa that its marginal tentacles should be very sensitive to contact with minute particles, so that a very slight stimulus applied to them should start the co-ordinated movements of localization, it is not surprising that the tentacular rim should present nerve-endings so far sensitive that only by their excitation can the reflex mechanism be thrown into action. But if such is the explanation in this case, it is curious that in *Tiaropsis indicans* every part of the bell should be equally capable of yielding a stimulus to a precisely similar reflex action.

In pursuance of this point I tried the experiment of cutting off portions of the margin, and stimulating the bell above the portions of the margin which I had removed. I found that in this case the manubrium did not remain passive as it did when the whole margin of the bell was removed; but that it made ineffectual efforts to find the offending body, and in doing so always touched some part of the margin which was still unmutated. I can only explain this fact by supposing that the stimulus supplied to the mutilated part is spread over the bell, and falsely referred by the manubrium to some part of the sensitive—i.e., unmutated—margin.

But to complete this account of the localising movements it is necessary to state one additional fact which, for the sake of clearness, I have hitherto omitted. If any one of the four radial tubes is irritated, the manubrium will correctly localise the seat of irritation, whether or not the margin of the bell has been previously removed. This greater case, so to speak, of localising stimuli in the course of the radial tubes rather than anywhere else in the umbrella except the margin, corresponds with what I found to be the case in *T. indicans*, and probably has a direct reference to the distribution of the principal nerve-trunks.

On the whole, therefore, contrasting this case of localization with the closely parallel case presented by *T. indicans*, I should say that the two chiefly differ in the freshwater Medusa, even when unmutated, not being able to localise so promptly or so certainly: and in the localization being only performed with reference to the margin and radial tubes, instead of with reference to the whole excitable surface of the animal.

All marine Medusæ are very intolerant of fresh water, and therefore as the fresh water species most presumably have had marine ancestors,¹ it seemed an interesting question to determine how far this species would prove tolerant of sea water. For the sake of comparison I shall first briefly describe the effects of fresh water upon the marine species.² If a naked-eyed Medusa which is swimming actively in sea water is suddenly transferred to fresh water, it will instantaneously collapse, become motionless, and sink to the

¹ Looking to the enormous number of marine species of Medusæ, it is much more probable that the freshwater species were derived from them, than that they were derived from freshwater ancestry.

² For full account, see *Phil. Trans.*, vol. clxvii., pp. 744-745.

bottom of the containing vessel. There it will remain motionless until it dies; but if it be again transferred to sea water it will recover, provided that its exposure to the fresh water has not been of too long duration. I have never known a naked-eyed Medusa survive an exposure of fifteen minutes: but they may survive an exposure of ten, and generally survive an exposure of five. But although they thus continue to live for an indefinite time, their vigor is conspicuously and permanently impaired. While in the fresh water irritability persists for a short time after spontaneity has ceased, and the manubrium and tentacles are strongly retracted.

Turning now to the case of the freshwater species, when first it is dropped into sea water at 85° there is no change in its movements for about fifteen seconds, although the tentacles may be retracted. But then, or a few seconds later, there generally occurs a series of two or three tonic spasms separated from one another by an interval of a few seconds. During the next half minute the ordinary contractions become progressively weaker, until they fade away into mere twitching convulsions, which affect different parts of the bell irregularly. After about a minute from the time of the first immersion all movement ceases, the bell remaining passive in partial systole. There is now no vestige of irritability. If transferred to fresh water after five minutes exposure, there immediately supervenes a strong and persistent tonic spasm, resembling rigor mortis, and the animal remains motionless for about twenty minutes. Slight twitching contractions then begin to display themselves, which, however, do not affect the whole bell, but occur partially. The tonic spasm continues progressively to increase in severity, and gives the outline of the margin a very irregular form; the twitching contractions become weaker and less frequent, till at last they altogether die away. Irritability, however, still continues for a time—a nip with the forceps being followed by a bout of rhythmical contractions. Death occurs in several hours in strong and irregular systole.

If the exposure to sea water has only lasted two minutes, a similar series of phenomena are presented, except that the spontaneous twitching movements supervene in much less time than twenty minutes. But an exposure of even one minute may determine a fatal result a few hours after the Medusa has been restored to fresh water.

Contact with sea water causes an opalescence and essential disintegration of the tissues, which precisely resemble the effects of fresh water upon the marine Medusæ. When immersed in sea water this Medusa floats upon the surface, owing to its smaller specific gravity.

In diluted sea water (50 per cent) the preliminary tonic spasms do not occur, but all the other phases are the same, though extended through a longer period. In sea water still more diluted (1 in 4 or 6) there is a gradual loss of spontaneity, till all movement ceases, shortly after which irritability also disappears; manubrium and tentacles expanded. After an hour's continued exposure intense rigor mortis slowly and progressively develops itself, so that at last the bell has shrivelled almost to nothing. An exposure of a few minutes to this strength places the animal past recovery when restored to fresh water. In still weaker mixtures (1 in 8, or 1 in ten) spontaneity persists for a long time; but the animal gradually becomes less and less energetic, till at last it will only move in a bout of feeble pulsations when irritated. In still weaker solutions (1 in 12, or 1 in 15) spontaneity continues for hours, and in solutions of from 1 in 15 to 1 in 18 the Medusa will swim about for days.

It will be seen from this account that the freshwater Medusa is even more intolerant of sea water than are the marine species of freshwater. Moreover the freshwater Medusa is beyond all comparison more intolerant of sea water than are the marine species of brine. For I have previously found that the marine species will survive many hours' immersion in a saturated solution of salt. While in such a solution they are motionless, with manubrium and tentacles relaxed, so resembling the freshwater Medusa shortly after being immersed in a mixture of 1 part sea water to 5 of fresh; but there is the great difference that while this small amount of salt is very quickly fatal to the fresh-water

species, the large addition of salt exerts no permanently deleterious influence on the marine species.

We have thus altogether a curious set of cross relations. It would appear that a much less profound physiological change would be required to transmute a sea-water jelly-fish into a jelly-fish adapted to inhabit brine, than would be required to enable it to inhabit fresh water. Yet the latter is the direction in which the modification has taken place, and taken place so completely that sea water is now more poisonous to the modified species than is fresh water to the unmodified. There can be no doubt that the modification was gradual—probably brought about by the ancestors of the freshwater Medusa penetrating higher and higher through the brackish waters of estuaries into the fresh water of rivers—and it would I think be hard to point to a more remarkable case of profound physiological modification in adaptation to changed conditions of life. If an animal so exceedingly intolerant of fresh water as is a marine jelly-fish may yet have all its tissues changed so as to adapt them to thrive in fresh water, and even die after an exposure of one minute to their ancestral element, assuredly we can see no reason why any animal in earth or sea or anywhere else may not in time become fitted to change its element.

GEORGE J. ROMANES.

A NEW GENUS OF RHINOCERONTIDÆ.

While the genus *Aphelops* must be regarded as the direct ancestor of the recent rhinoceroses with canine and incisor teeth, now confined to Asia and the Islands, the ancestral genus of the African forms and their extinct congeners, which are without the teeth named, is less known. It can now be shown that the missing genus inhabited North America, and that, like *Aphelops*, it is hornless. It may be named and characterized as follows: *Peraceras*, Cope; superior dentition; I. o; C. o; P-m. 4; M. 3; nasal bones weak, hornless.

This genus is established on a new basis recently discovered by Mr. R. H. Hazard, in the Loup Fork formation of Nebraska, which may be called *Peraceras superciliosus*. It is founded on a nearly perfect skull, which lacks the lower jaw. Its size is about that of the Indian rhinoceros. It is narrowed anteriorly, but is very wide between the orbits. Posterior to these it contracts rapidly, and rises to a rather elevated occiput. Sagittal crest narrow; a prominent angle above each orbit. The premaxillary bone is narrow and weak. The nasal notch extends to above the middle of the third superior premolar. The occiput is rectangular in outline, with truncate summit. Its surface above is concave, divided by a strong median crest; lower down a vertical groove intersects its lateral border. The crests of the molar teeth are rather simple, and the posterior notch is soon isolated on attrition. Wear also isolates an external median fossa of the second premolar. Length of skull from end of premaxillary bone to condyles, M. 700; length of alveolar border of premaxillary, .025; length of molar series, .315; length of three true molars, .160; width of crown of second true molar at base, .075; superciliary width, .255.

This species is nearest to the *Peraceras malacorhinus*, a species which I formerly referred to *Aphelops*, but which I have little doubt belongs to the present genus. It differs from *P. superciliosus* as follows: In the latter species the front is wider, and is plane or concave, not convex; the superior edge of the maxillary is not wide and incurved, and has not the oblique ridges; the infraorbital foramen consequently has a more lateral opening. The narial notch does not extend so far posteriorly by the one and a half molar teeth. The occiput is wider, is divided by a median crest not found in *P. malacorhinus*, and has the vertical lateral grooves much shorter. The acute supraorbital angle is not seen in the *P. malacorhinus*.

The rhinoceroses of the Loup Fork formation whose generic position can now be ascertained, are the following: *Peraceras malacorhinus*; *P. superciliosus*; *Aphelops meridi-anus*; *A. Negalodus*; *A. fossiger*.—*Am. Naturalist*.

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ANALYSIS OF WATER.

The trouble attending the making of analyses of water is considerable, and may account for the reluctance of chemists to make such investigations unless under special orders.

As the value of such analysis of the water supply of cities is great, especially at a time when the subject is receiving so much attention, we gladly welcome some valuable work accomplished in this direction at Newark, New Jersey, by Dr. Herman H. C. Herold, of that city, and placed at the disposal of "SCIENCE."

As Dr. Herold has made his calculations both for grains in the imperial gallon, and also according to the metric system, we reproduce both in tabular form.

To this record is added the analysis of water from a New York well, also made by Dr. Herold, and described by him at page 13 of this Journal, forming part of No. 2, issued July 10th last.

The inference Dr. Herold draws after making these analyses, is that relatively the water from the Passaic river stands at the head of the list, as being the most favorable as a water supply for Newark, in comparison with that obtained from driven wells.

Still the Aqueduct Water (Passaic) is not in a satisfactory condition, its imperfections being due to impurities derived from the city of Newark itself, and not from Paterson and other towns above it, as the run of twelve miles would oxidize such organic matter.

The results of an analysis of the aqueduct water of Newark City, made by Dr. Herold in the month of June, as compared with the results of the analysis made in March, shows a decided deterioration in the condition of the water during the time between the two periods. To a very great extent this may be explained as being a result of natural causes. During the interval we suffered from a prolonged drought, the lowlands being thoroughly drained and converted into pools, the flood-tide, flowing farther up the river than is usual, carried with it much of the impurities of the city which are emptied into the river. The distance being short, these impurities did not have adequate opportunity for oxygenation and destruction. As will be seen by a comparison of the following tables, the amount of solid residue, 6.688 grains per imperial gallon, is about double that obtained by the former analysis, which showed only 3.147 grains per imperial gallon. The amount of organic matter has increased $2\frac{1}{2}$ times, or 0.957 grains against 0.378 grains of the former analysis. A still more alarming increase is found in the chlorine, 0.636 grains to 0.211 grains, found in the former analysis—an increase of 300 per cent.

Dr. Herold also states that his views regarding the advantages of securing a water supply for cities from running streams is strengthened by further examination of the question and everyday experience. Whatever organic matter may find its way into a running river is necessarily largely diluted. In the constant change of position and great increase of surface it is exposed to the oxygen of the air and also to that in the water; the plants along the bottom and sides of the stream are sure to absorb a certain proportion and by these means, if the water is only given far enough to flow, the matter contained in it cannot but be neutralized and to a very great extent destroyed. The great advantage to cities in being supplied from such a source is now generally conceded by all authorities who have made the subject of hygiene a study.

CONSTITUENTS.	1880. GRAINS IN AN IMP. GAL.						
	Newark City Aqueduct.		Public Well, cor. Orange and Broad Streets, Newark.	Public Well, cor. Ferry and Con- gress Streets, Newark.	Balbach's Arte- sian Well, Newark.	Newark Driven Well.	New York Driven Well.
	March.	June.	March.	March.	March.	June.	June.
Total solid constituents.....	3.147	6.688	22.277	36.929	125 833	49.782	31.434
After incineration.....	2.377	.....	17.673	21.312	92.849	.....	.....
Lime (CaO).....	1.357	1.225	7.150	6.842	40.953	6.040	4.396
Sulphate of lime (CaO, SO ₃ , 2 HO).....	None.	.....	6.016	6.016	120.346	6.052	8.665
Carbonate of lime (CaO, CO ₂).....	2.220	.....	9.270	8.717	3.155	7.940	.....
Bicarbonate of lime (CaO, 2 CO ₂).....	.....	.....	.....	.....	.....	.....	3.394
Magnesia, (MgO).....	Trace.	0.452	Trace.	Trace.	Trace.	2.468	3.162
Chloride of Magnesium (Mg Cl ₂).....	.....	.....	.....	.....	.....	.....	1.815
Carbonate of Magnesia (5 MgO, 4 CO ₂ , 6 HO).....	.....	.....	.....	.....	.....	.....	5.824
Chlorim (Cl).....	0.211	0.636	3.392	5.939	0.845	5.981	.....
Chloride of Sodium (Na Cl).....	0.379	.....	5.596	9.794	1.398	8.486	6.374
Soda (Na ₂ O).....	.....	0.318	.....	.....	.....	13.901	8.215
Sulphuric Acid (SO ₃).....	None.	1.245	2.798	2.798	55.974	12.187	4.315
Sulphate of Sodium (Na ₂ O, SO ₃).....	.....	.....	.....	.....	.....	9.865	5.096
Iron (Fe O).....	Trace.	.....	Trace.	Trace.	Trace.	11.188	.....
Silica (Si O ₂).....	Not estimated	1.293	Not estimated.	Not estimated.	Not estimated.	4.701	1.736
Carbonic Acid (CO ₂).....	.....	0.705	.....	.....	.....	7.199	4.396
Organic and Volatile matter.....	0.378	0.957	1.395	12.408	None.	7.374	6.446

CONSTITUENTS.	1880. GRAMMES IN A LITRE.						
	Newark City Aqueduct.		Public Well cor. Orange and Broad sts., Newark.	Public Well cor. Ferry and Congress sts., Newark.	Balbach's Arte- sian Well, Newark.	Newark Driven Well.	New York Driven Well.
	March.	June.	March.	March.	March.	June.	June.
Total solid constituents.....	0.0450	0.0956	0.3184	0.5278	1.7884	0.7115	0.4485
After incineration.....	0.0340	.....	0.2526	0.3046	1.3270	.....	.....
Lime (CaO).....	0.0194	0.0176	0.1022	0.0780	0.5853	0.0992	0.0692
Sulphate of lime (CaO, SO ₃ , 2HO).....	None.	0.0298	0.0860	0.0860	1.7200	0.0865	0.1236
Carbonate of lime (CaO, CO ₂).....	0.0346	0.0096	0.1325	0.1246	0.0451	0.1135	.....
Bicarbonate of lime (CaO, 2CO ₂).....	.....	.....	.....	.....	.....	.....	0.0471
Magnesia (MgO).....	Trace.	0.0064	Trace.	Trace.	Trace.	0.0353	0.0451
Chloride of Magnesium (MgCl ₂).....	.....	0.0050	.....	.....	.....	.....	0.0259
Carbonate of Magnesia (5 MgO, 4CO ₂ , 6 HO).....	.....	0.0105	.....	.....	.....	0.0855	0.0830
Chlorine (Cl).....	0.0030	0.0090	0.0485	0.0849	0.0121	0.1213	0.0969
Chloride of Sodium (NaCl).....	0.0050	0.0086	0.0800	0.1400	0.0200	0.1087	0.1172
Soda (Na ₂ O).....	.....	0.0035	.....	.....	.....	0.1742	0.0616
Sulphuric Acid (SO ₃).....	None.	0.0175	0.0400	0.0400	0.8000	0.1410	0.0727
Sulphate of Sodium (Na ₂ O, SO ₃).....	.....	.....	.....	.....	.....	0.1599	.....
Iron (FeO).....	Trace.	.....	Trace.	Trace.	Trace.	.....	.....
Silica (SiO ₂).....	Not estimated.	0.0185	Not estimated.	Not estimated.	Not estimated.	0.0672	0.0248
Carbonic Acid (CO ₂).....	.....	0.0101	.....	.....	.....	0.1029	0.0627
Organic and Volatile matter.....	0.0054	0.0136	0.0104	0.1778	None.	0.1054	0.0920

We have been shown a number of photographs copyrighted by Mr. Geo. Cumming, of this city, entitled, 'Studies of the Color Glow, or Rectilinear Spectrum.' The original colored line drawings which were exhibited in 1879, at the Academy of Design and American Institute, consist of geometrical forms drawn in straight lines, in many hues of color, forming central globes with bright scintillating effects. While the photographs give but the form on a much reduced scale without, of course, the chief beauty—the blended color-lines—they are curious as illustrating the depth of tone obtained by the camera from any given shade or tint—light green for instance coming out deep black and violet being almost lost in the process. The originator has more of an artistic than a practical feeling in their conception, and calls his vari-

ous designs *spring, sunset, autumn, sunrise*, etc; his idea being to embody a theory of color with pleasing effect, rather than to stamp himself as either an artist or designer.

We desire to direct special attention to the meeting of the American Society of Microscopists at Detroit, on the 17th of this month, presided over by Professor H. L. Smith, of Hobart College, Geneva, N. Y.

The conception of such a national meeting of microscopists is most excellent, and under such able leadership the results of the meeting cannot fail to promote the extension of microscopical research, and its elevation to the high position it should occupy, as one of the greatest aids to our possession of scientific knowledge, the comprehension of the workings of Nature and "of things around us."

NEW SOURCES OF FOOD.

BY W. N. LOCKINGTON.

Advance in civilization is marked by an advance in the choice of food. In the words of Spencer, "There is an analogy between progress in bodily nutrition and progress in mental nutrition. The higher types of mind, like the higher types of body, have greater powers of selecting materials fit for assimilation."

As there is room for much further advance in mental nutrition, so is there for much advance in bodily nutrition. The choice of food has hitherto been determined empirically. Prejudice is the usual guide. A few experiments with foods, and finding some hitherto unused or little known article to be exceedingly nutritious, or to supply a want, they recommend its adoption, but either their recommendation is unheeded, or the new article wins its way into favor with exceeding slowness.

The multitudinous forms of animal and vegetable life could furnish us with many an article of food equal or superior to those in use. We have not yet been through the full range of nature in our search for food. Yet our wide-spreading commerce has made us familiar with many foods that were formerly unknown, so that, prejudiced though we are, our range of food is wide compared with that of our ancestors, or that of a savage, but almost all the plants we grow for food purposes, as well as almost all the animals we eat, are, if not those used by our own ancestors, those which have been used for ages by other peoples with whom we have come in contact. It is the same with animals and vegetables used in the arts. We have adopted them from others—few indeed have had their merits discovered and utilized.

The seed of certain grasses and certain leguminous plants have for thousands of years been the chief sources of nutriment procured by man from the vegetable world, and they fulfill his purpose well; but the two immense orders of *Leguminosae* and *Gramineae*, the latter entirely, the former chiefly composed of plants that are adapted for food, could furnish many additional species that would not only vary our dietary, but give us a supply of food under conditions that preclude the growth of species now in use. The number of fruits cultivated might be greatly increased. Almost every section of country furnishes some nut or berry which even in its wild state is pleasant to the taste.

What might not cultivation do for some of these. It has given us all the varieties of plum and cherry, apple and pear, from sour and unpromising originals, and the long category of vines from one European species. Many edible roots, stems and leaves have yet to be discovered or improved into value.

A few species of the order *Cruciferae* are eaten, while the rest are neglected. Yet the whole order is good for food. A botanist could multiply examples throughout the range of vegetable life, but it will suffice here to give one more; the mushroom or fungus tribe, so little known, so much dreaded, yet containing so many edible species. Again and again it has been shown that the same amount of observation which enables a man to distinguish night-shade from the potato, or carrots from hemlock, would enable him to discriminate between the poisonous and edible mushrooms, yet only an enthusiastic band ever dares to venture beyond the conventional species. The species favored by the Anglo-Saxon is in ill-favor with the Italian, who has a wider range of edible fungi, as have also the Frenchman and the Russian.

As mushrooms can be grown in places where ordinary plants will not flourish, an increased taste for and knowledge of them would be of great benefit to our poor. If from the vegetable world we turn to the animal, we find prejudice and ignorance still more rampant. The Mosaic law is still obeyed in this matter by nations who break it in most others.

The ordinance which restricted the Israelites to the use, for food purposes, of such quadrupeds only as chew the cud and divide the hoof, was in the then state of knowledge a wise and safe one.

All such animals are herbivorous, and are better fitted for

food than carnivorous mammals. They are of large size, furnish an abundance of healthy muscle, and have in many instances been domesticated for ages. But numerous other large animals are herbivorous also, and extensive series of small animals are graminivorous or frugivorous, devourers of seeds or fruits. Why should not these be eaten? The omnivorous pig, whose diet, at least in a state of domestication, is not particularly choice, and whose flesh is less nutritious and less wholesome than that of most other mammals, is largely eaten by man, yet the prejudice against horse flesh is almost universal among Aryans.

We occasionally eat a hare or rabbit, but the rest of the rodentia, mostly seed or root eaters, are neglected. The ground squirrels, a plague on the Pacific slope of the United States, would cease to be so were man to make a systematic onslaught upon them to gratify his taste. Their flavor is pronounced excellent by all who have tried them. The taste for this or that particular article of food is to a great extent acquired.

Many who ultimately become fond of oysters dislike them at first. The same remark holds true of many other foods in common use. The muscles of all birds and mammals are suitable for food when in a perfectly healthy condition. More care is necessary in the case of carnivorous mammals, since their flesh decays more rapidly; yet it is doubtful whether one person in ten could distinguish cat from rabbit were they cooked alike and the more tell-tale portions removed.

The strong or fishy flavor of marine mammals and birds would doubtless be objected to by those whose gustatory nerves had learned to relish high game and Limburger cheese, yet as safe sources of nutriment they would at least be superior to the former.

Civilized nations of Aryan descent devour many mammals and birds, some batrachia and many fishes; but the intervening class of reptiles is almost wholly ignored. Why? Simply because of the pious horror of the snake. Lizards, as they have long tails, are viewed only a little less unfavorably, while tortoises—thanks to their widely different form—are accepted with some reservation; yet the flesh of snakes and lizards is as firm, as nutritious and as healthy as that of fishes, if not more so; and those who have eaten them when among peoples who do not share our prejudices, have had their own shaken. The Frenchman, who is a good cook, eats frogs; the Englishman cannot conquer his prejudice.

Leaving the vertebrata; the choice made by civilized nations among the invertebrata is highly eccentric.

A Spaniard or Frenchman relishes a cuttle fish, which an American or Englishman shudders at; and the harmless snail and slug, *per se* as good food as oysters, are esteemed by some nations and detested by others.

There is little doubt that the great majority of mollusks of sufficient size are healthy food, and that man has yet to discover among them many a *bonne bouche*.

Descending lower still, sea-urchins, sea-anemones and sea-cucumbers are eaten by some highly civilized nations, and who can tell how acceptable they might prove to an Anglo-Saxon could he but conquer the horror he feels at their appearance.

P. H. Gosse, so well known for his interesting works on natural history, tells us how he cooked the common sea-anemone of the English coasts (*Actinia mesembryanthemum*), and how fond his little one became of it, asking for "more tinnies."

Probably the classes of animals which are of least value as food to man are those included in the sub-kingdom Arthropoda, namely, insects, arachnids, myriapods and crustacea, the multitudinous types groaped together as *Vermes*, or worms, and the uni-celled organisms, or Protozoa. Some of the larger crustacea, known as crabs, lobsters, crayfish and shrimps, are eaten as delicacies, and it is probable that many other species are equally edible, but the vast majority of the class is only of value to man inasmuch as it furnishes food for larger marine animals.

Insects are eaten by many wild tribes. Some of the Indians of the Pacific coast find in the abundance of grasshoppers that plague the white man, an abundant store of food. Similar Orthoptera are largely consumed by the

natives of South Africa, and those of some of the Sunda Isles esteem dragon-flies a great delicacy, catching them, according to Wallace, on birdlimed twigs. Though there can be comparatively little nutriment in the soft bodies of insects, yet there is no reason for the horror with which they are regarded, as articles of food, by the Aryan races. A fancy for the flavor of the Rocky Mountain locust would go far toward decreasing the devastation of that dreaded pest.

Some of the marine worms are accounted delicacies by certain tribes, but the greater part of the varied forms belonging to the sub-kingdom must be regarded, so far as they are useful to man at all, as only indirectly so through their consumption by animals he feeds upon. The same may be said of the Protozoa, which, swarming in countless numbers in sea and river, lake and marsh, furnish food for the creatures above them.

Putting aside all question of protection or preservation of plants and animals now used as food, the examples adduced are sufficient to show that the range of foods might, with advantage, be greatly extended.

Much remains to be learned respecting the diseases and bodily states of cold-blooded animals and of the invertebrata before we can use them for food with the same confidence with which we eat beef, mutton or poultry. The diseases of the higher animals are, to a great extent, similar to our own, and we have learned how to discriminate; but we do not recognize the diseases of fishes, crabs and shell-fish. The stories of poisonous fish probably arise from this source. Every year we hear of cases of poisoning, well authenticated, from eating mussels, lobsters or other crustacea, or mollusks, which are usually healthy food. All these creatures are subject to diseases which we have not yet studied, and it may be that at certain seasons, such as immediately after reproduction, some of them are unfit for food. This is one well-grounded cause of prejudice, but one which will be removed as our knowledge of the lower forms of life extends.

The animal and vegetable world furnish us with other things besides food. Materials of other descriptions furnish, by their manufacture, a means of procuring food to some, while the articles manufactured are of use to all. Commerce, which has made us familiar with foods previously unknown, has helped us still more in this direction, yet when we consider the great variety of vegetable and animal life, we cannot but believe that much more remains to be discovered, or, at least, utilized.

Other nations, many of them but semi-civilized, others barbarous, have, in these things, been our teachers. As maize and potatoes were known to the Indians before we learned to use them, so was *Phormium tenax* to the Maoris, and cotton to the Hindoos and Chinese.

When it is remembered what vast industries depend upon the supply of fibrous plants, and, that a fibre with different qualities, as it could be applied to new uses, would start a new branch of trade; when we see how extensive are the manufactures carried on from gum-resins like caoutchouc, or gutta-percha, we must acknowledge that the discovery of a fiber or a resin with new uses would furnish a livelihood to many additional workers. Take paper for example. Until lately this article was made from linen rags, but as the supply of that material fell short of the demand, cotton waste, straw, the Yucca plant, and other vegetable materials came into use, and it is evident that it can be made from almost any fibrous substance reduced to a pulp. Few are the plants that cannot be utilized by man. If valueless for food or for building purposes, a fiber, a gum, an essential oil, a medicinal product, may be found in most.

The constantly-increasing stock of geographical and botanical knowledge brings new materials into the notice of scientists, and the constantly increasing needs of mankind brings them slowly into public notice. The secretion lately found in Arizona, upon the branches of *Larrea Mexicana*, and of another plant, may yet enable us to dispense with the imported lac from Asia. Chemically the two seem identical; practically the despised Indian, here again our teacher, has long ago proved its use in the mending and making of vessels for cooking purposes.

Here is a case of a new material furnished by the animal kingdom, for it appears almost certain that the secretion, like that of wax or honey, is elaborated by the insect from the juices of the plants it feeds upon. Insects, so little used for food, so terribly destructive to our food plants and annoying to our domestic animals, may yet yield to us many useful materials; may yet prove in this respect among the most useful of organisms. Silk, honey, wax, gum-lac, cochineal, all are insect products, elaborated by insects from plants; and the last two are the produce of *coccidee*, those destroyers of our orchards and orangeries. Does not this point a way to the utilization, in some cases, of our insect pests?

The higher animals may not furnish us with many additional materials. Horn, hair, fur, wool, hides, feathers, bone, ivory, have their known uses. Improvement here is to be looked for rather in new uses for known materials than in the discovery of new ones. But the lower animals may yet yield us many useful substances. The great treasure house of the sea holds more than we have yet learned the use of. Shells, corals, the honey axes of soft-corals, and many other portions of marine animals, may be utilized for something more than show; and other secretions may be found as useful as those of the sepia. But though the number of useful species—useful either directly or indirectly—is so large that it includes probably the greater portion of existing organisms, yet some are far more useful than others, and some are directly injurious to more useful organisms. Such species need not be cultivated, except where they do not come into direct competition with more useful ones; but their consumption or use by man would diminish their numbers and give room for the more useful forms, which are now often permitted by man, even in his own cultivated fields, to be crowded out by the less useful.

—*Scientific Press*, Cal.

Two eggs of the extinct great auk were sold by auction in Edinburgh recently, both being purchased by Lord Lillford, one at £100, the other at 102 guineas, probably the largest sum ever paid for a single egg, with the exception of that of the moa, a single specimen of which was sold at the same place in 1865, for £200.

PROGRESS IN UTILIZATION OF SOLAR HEAT.—Since May, last year, M. Mouchot has been carrying on experiments near Algiers with his solar receivers. The smaller mirrors (0.80 m. diameter) have been used successfully for various operations in glass, not requiring more than 400° to 500°. Among these are the fusion and calcination of alum, preparations of benzoic acid, purification of linseed oil, concentration of syrups, sublimation of sulphur, distillation of sulphuric acid, and carbonization of wood in closed vessels. The large solar receiver (with mirror of 3.80 m.) has been improved by addition of a sufficient vapor chamber and of an interior arrangement which keeps the liquid to be vaporized constantly in contact with the whole heating surface. This apparatus on November 18, last year, raised 35 litres of cold water to the boiling point in 80 minutes, and an hour and a half later showed a pressure of eight atmospheres. On December 24 M. Mouchot with it distilled directly 25 litres of wine in 80 minutes, producing four litres of brandy. Steam distillation was also successfully done, but perhaps the most interesting results are those relating to mechanical utilization of solar heat. Since March the receiver has been working a horizontal engine (without expansion or condensation) at a rate of 120 revolutions a minute, under a constant pressure of 3.5 atmospheres. The disposable work has been utilized in driving a pump which yields six litres a minute at 3.50 m. or 1,200 litres an hour at 1 m., and in throwing a water-jet 12 m. This result, which M. Mouchot says could be easily improved, is obtained in a constant manner from 8 A. M. to 4 P. M., neither strong winds nor passing clouds sensibly affecting it.

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Not only in stirring up an interest in scientific work is the American Society valuable, but in original research it will yet make its name known, as even now among its members may be found many of the leading scientific workers with the microscope in this country. The officers of the Society, and of the Detroit meeting are as follows:

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THE TAY BRIDGE DISASTER.

The report of the Court of Inquiry appointed to investigate the circumstances of the fall of the Tay Bridge last December, which was fatal to so many hundred lives, has been made public, and the result is thus summarized and commented upon by *Nature*:

There appears to be some difference of opinion amongst the members of the court respecting the scope of the inquiry and the duties placed upon them by the Board of Trade, in consequence of which two separate reports appear together, one by Col. Yolland, Chief Government Inspector of Railways, and Mr. Barlow, President of the Institute of Civil Engineers, and the other by Mr. Rothery, the Wreck Com-

missioner. The former report describes in detail the design and method of erection adopted in the bridge, giving also a description of the various alterations in the plan which were rendered necessary as the work progressed.

The bridge was 3,465 yards in total length, divided into 86 spans, and it was the central portion, of 3,149 feet in length, which fell on the evening of December 28. As originally designed, this central position was to consist of lattice girders of 200 feet span, carried by brickwork piers somewhat over 80 feet in height from high-water level, but as the river bottom turned out to be different from what was expected from the borings, and the difficulty of obtaining a secure foundation greater, eleven spans of 245 feet and two of 227 feet were substituted, and braced iron piers were adopted in the place of brickwork, as imposing a less weight on the foundations. It is these piers which at the inquiry chiefly received attention, as there can be little doubt that they were the immediate cause of the catastrophe. The process of floating out and sinking the caissons for these piers has already been described in these columns, and so successfully was this—certainly the most difficult and hazardous part of the undertaking—accomplished, that no suggestion of insufficient strength has been made, and in the Report it is stated that there is nothing to indicate any movement or settlement in the foundations of the piers which fell.

The caissons were lined with brickwork and filled with concrete, on which was built a hexagonal pier of masonry carried up to 5 feet above high-water mark. Upon this pier was built up six cast-iron columns secured by holding-down bolts to the masonry at the angles of the hexagon. The columns were made up of lengths united by flanges and bolts, and connected with each other by horizontal struts and diagonal ties. The up-stream and down-stream columns were each 18 inches in diameter, the remaining four, 15 inches; all were inclined 12 inches inwards at the top. The piers thus formed were from 81 to 83 feet in height from the top of the masonry to the under-side of the girders. The diagonal bracing consisted of flat bars attached to the columns by means of "lugs" cast on them, being secured at one extremity by a screw-bolt passing through the lugs and bar, and at the other by a strap provided with a gib and cotter for tightening up. The horizontal struts consisted of two channel-bars bolted back to back to a single lug on each column.

It will thus be seen that all vertical load must be borne entirely by the columns, and with the exception of the small transverse resistance of the latter the whole of any lateral pressure must be transmitted by the bracing.

Whether as designed the bridge would have been strong enough for its work if the materials and workmanship had been good throughout is very doubtful, but, as carried out, the evidence shows distinctly that it was not sufficiently substantial for the heavy traffic and severe gales to which it was exposed. When everything was tight and in good order the bridge, at the time of its inspection by General Hutchinson in February, 1878, showed great rigidity under the tests imposed by him, but by October of the same year so much slackness had made its appearance in the bracing that, besides the ordinary keying-up by driving the cotters, more than 100 packing-pieces about three-eighths of an inch thick had to be introduced in different parts.

Respecting the immediate cause of the accident the Court states—"In our opinion the weight of evidence points out the cross bracing and its fastening by lugs as the first part to yield." This we believe the calculations of Dr. Pole and Mr. Stewart, taken in connection with the experiments of Mr. Kirkaldy, are quite sufficient to establish. With a wind pressure of 30 lbs. to the square foot on the windward girder and train, and half this amount on the leeward girder, the stress on the tie-bar most severely strained, would be 16·8 tons, or 10·18 tons per square inch; again, with a wind pressure of 40 lbs. to the square foot the stress on the tie-bar would be 22·4 tons. Now, as Mr. Kirkaldy's experiments, made by order of the court on some of the tie-bars removed from the bridge, showed that they broke with a load of from 19 to 23 tons, and the corresponding lugs with a load of 23 to 25 tons, it is pretty certain that the ultimate strength of this part of the structure would be reached by a wind pressure of 40 lbs. to the square foot.

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missioner. The former report describes in detail the design and method of erection adopted in the bridge, giving also a description of the various alterations in the plan which were rendered necessary as the work progressed.

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The caissons were lined with brickwork and filled with concrete, on which was built a hexagonal pier of masonry carried up to 5 feet above high-water mark. Upon this pier was built up six cast-iron columns secured by holding-down bolts to the masonry at the angles of the hexagon. The columns were made up of lengths united by flanges and bolts, and connected with each other by horizontal struts and diagonal ties. The up-stream and down-stream columns were each 18 inches in diameter, the remaining four, 15 inches; all were inclined 12 inches inwards at the top. The piers thus formed were from 81 to 83 feet in height from the top of the masonry to the under-side of the girders. The diagonal bracing consisted of flat bars attached to the columns by means of "lugs" cast on them, being secured at one extremity by a screw-bolt passing through the lugs and bar, and at the other by a strap provided with a gib and cotter for tightening up. The horizontal struts consisted of two channel-bars bolted back to back to a single lug on each column.

It will thus be seen that all vertical load must be borne entirely by the columns, and with the exception of the small transverse resistance of the latter the whole of any lateral pressure must be transmitted by the bracing.

Whether as designed the bridge would have been strong enough for its work if the materials and workmanship had been good throughout is very doubtful, but, as carried out, the evidence shows distinctly that it was not sufficiently substantial for the heavy traffic and severe gales to which it was exposed. When everything was tight and in good order the bridge, at the time of its inspection by General Hutchinson in February, 1878, showed great rigidity under the tests imposed by him, but by October of the same year so much slackness had made its appearance in the bracing that, besides the ordinary keying-up by driving the cotters, more than 100 packing-pieces about three-eighths of an inch thick had to be introduced in different parts.

Respecting the immediate cause of the accident the Court states—"In our opinion the weight of evidence points out the cross bracing and its fastening by lugs as the first part to yield." This we believe the calculations of Dr. Pole and Mr. Stewart, taken in connection with the experiments of Mr. Kirkaldy, are quite sufficient to establish. With a wind pressure of 30 lbs. to the square foot on the windward girder and train, and half this amount on the leeward girder, the stress on the tie-bar most severely strained, would be 16·8 tons, or 10·18 tons per square inch; again, with a wind pressure of 40 lbs. to the square foot the stress on the tie-bar would be 22·4 tons. Now, as Mr. Kirkaldy's experiments, made by order of the court on some of the tie-bars removed from the bridge, showed that they broke with a load of from 19 to 23 tons, and the corresponding lugs with a load of 23 to 25 tons, it is pretty certain that the ultimate strength of this part of the structure would be reached by a wind pressure of 40 lbs. to the square foot.

And, in addition to this, more variation is to be expected in the strength of the lugs, as some at least were admitted to be of bad manufacture, and when the pier was most severely strained it would be some of the worst lugs in the lower tiers that would be the first to yield; thus the samples taken for testing would not be likely to embrace specimens of the lowest strength, as these would probably have already given way.

Again, it does not appear necessary to assume a wind pressure of 40 lbs. per square foot to ensure the destruction of the pier; the stresses above mentioned are due merely to the static pressure, and it can hardly be denied in the face of the evidence respecting the details of the structure that there would be a great deal of motion due to backlash over and above the elastic yielding of the material. Thus a much lower pressure would produce the effects calculated for one of 40 lbs. per square foot.

The principal conclusions arrived at by the court are that there is no indication of settlement in the foundations, that the wrought iron employed was of fair strength, though not of high quality as regards toughness, that the cast iron was fairly good, that the main girders were of sufficient strength, and that the iron piers, though strong enough to sustain the vertical load, were insufficient to resist the lateral action of heavy gales from the weakness of the cross bracing and its fastenings; that the railway company did not enforce the recommendation of General Hutchinson by limiting the speed of trains over the bridge to twenty-five miles per hour, much higher speed being frequently run; that while of opinion that the fall of the bridge was occasioned by the yielding of the cross bracing and fastenings, it might possibly have been due to the fracture of one of the outward leeward columns.

Colonel Yollard and Mr. Barlow conclude by stating "that there is no requirement issued by the Board of Trade respecting wind pressure, and there does not appear to be any understood rule in the engineering profession regarding wind pressure in railway structures; and we therefore recommend that the Board of Trade should take such steps as may be necessary for the establishment of rules for that purpose."

Mr. Rothery, in his independent report, while stating that there is an entire agreement between himself and his colleagues in the conclusions arrived at from the evidence, goes further than they, and unhesitatingly apportions the blame among the different parties concerned. On the recommendation that the Board of Trade should establish rules providing for wind pressure, he differs from his colleagues, emphatically stating that it is for the engineering profession to make them, and evidently regards the superficial character of an official inspection as no great evil.

Where French engineers have long adopted 270 kilogrammes per square metre, and many English engineers, on the authority of Rankine, the equivalent 55 lbs. per square foot, while nearly the same figure is used in America, it seems strange that so much difference of opinion should be found to exist; but one thing at least is certain, that the instruments at present in use for measuring wind pressure are exceedingly crude and liable to error, and that until these are improved and much increased in number there is little chance of being on the spot when these excessive pressures occur, or of truthfully recording them when met with.

Respecting the transfer of these responsibilities to a Government Department, we believe that such apronstring policy would be fatal to the profession of the civil engineer; we would rather see the Board of Trade Inspection, which at least is formal and superficial, relaxed than any attempt made to increase its efficiency. The medical profession does not require a fatherly department to watch over its operations or give an opinion on an amputation; why then should the engineering profession? It cannot be too clearly understood that an engineering work cannot be successfully carried out by mere rule of thumb or even by the copious use of "Molesworth" or "Rankine"; each operation is to some extent a physical experiment, subject to known laws, but under variable conditions. The physicist and the engineer have already to a great extent established the laws for themselves, but it remains for the scientific engineer to carefully watch their operation, and thus gain

that practical experience which will enable him to deal with each special case as it arises.

The conclusions we draw from the evidence and report are that the design of the piers was most imperfect, cheapness appearing to be the ruling element in every detail, a cheapness too that must have been completely delusive, as any money saved in first cost would soon, in such a rickety structure, have been swallowed up in maintenance. At nearly all points an absence of consideration for small details is most apparent, indicating probably that these were intrusted to some subordinate, who failed to appreciate their importance.

It is very far from our object in this article to hold up any particular individuals to blame for this disaster, but we should like to point out on whom the responsibility should rest if such a thing should occur again.

It would be quite impracticable for the Board of Trade to exercise such supervision over the selection of the material and the execution and erection of a large work throughout its progress, as would render its certificate of any value; we believe, therefore, that the undivided responsibility should rest on the engineer. Any dishonesty on the part of the contractor or his workmen—and we are sorry to believe this still exists in some cases—could be easily rendered hazardous by legal penalties.

Doubtless with the keen competition of the present day things must be "cut finer" than they used to be: but while we would remove any arbitrary restrictions imposed by Government on the judgment of those who ought to be best able to appreciate the particular conditions of their own work, we should be very sorry to see the introduction of flimsy structures or reckless traffic arrangements without it being understood on whom the responsibility rested in case of failure.

A letter recently sent to Professor Plantamour, director of the Geneva Observatory, gives the details of a singular phenomenon observed at Bonneville on the 25th of April. It was noticed during a rain storm, that the drops of water falling upon dark clothes, linen, umbrellas, left a dirty yellow spot verging on brown. The matter was given over to M. de Candolle, for investigation, who found that the powder which colored the yellow rain, contained only organic elements of vegetable origin. Observed dry, or in pure water, these *débris* had mostly a yellowish color, but some were colorless. They were generally formed of cells of small diameter, upon the walls of which were granulations consisting of the finest particles of the pulverulent matter of the rain drops. The advanced state of disaggregation of all these vegetable *débris*, did not allow of the determination of their origin; but the minuteness of the cells seemed to indicate that they belonged to young tissues. Amongst the fragments, with form so varied and irregular, were found some spores of cryptogams, but no grains of pollen were met with.

M. Dines has calculated that the amount of dew deposited on the ground in the course of a year would be represented by a layer of water about 40 millimetres (1.6 in.) in height, equivalent to 40 litres per square metre.

The Royal Society of New South Wales now numbers 430 members, exclusive of honorary and corresponding members. Mr. G. Bentham, Dr. Darwin, Prof. Huxley, Prof. Owen and Sir J. D. Hooker have been elected honorary members, and Mr. R. Etheridge, jun., a corresponding member. The Clarke memorial medal for 1878 has been awarded to Prof. Owen, for 1879 to Mr. G. Bentham, and for 1880 to Prof. Huxley, for their contributions to palæontology, botany and natural history of Australia.

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This work will serve the very useful purpose of placing within reach of those who are not acquainted with the history and growth of electric lighting, a clearly written description, well illustrated with wood engravings. It is not a text book, and the author makes no pretensions to teach electricians the art of electric lighting, but it is, in fact, a popular guide to the subject.

The rapid development in the various forms of electric lighting led to a re-arrangement of the book, even while it was being written; it is not therefore surprising to find that on certain points the work is already obsolete. The chapter on the Edison electric lamp was written twelve months since, and is devoted chiefly to his experiments with incandescent platinum, which has been long since abandoned, while the author merely speaks of the carbon lamps to prophesy their failure. Reading this, at this date, when every difficulty in the way of their practical use has been removed, and arrangements are in progress to produce them in sufficient numbers to permit their general adoption, we cannot but regret that prejudice has been allowed to derange the better judgment of those who have assumed to lead public opinion on this subject.

We do not propose to examine too critically what is admitted to be a popular work, and while we are not in accord with much we find in the book, we have no doubt that the numerous wood-cuts of electric generators and other apparatus will be most useful to those who desire to acquaint themselves with the various methods of electric lighting.

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The author appears to have had fifteen years' of practical experience as an alkali manufacturer, during which time he states he has erected new plants, remodeled old works, and trained managers. We advise all engaged in the alkali manufacture, to procure this most practical work, as from the examination we have made of it, we feel sure a perusal will be the means of saving infinite time, patience and labor.

NOTES AND QUERIES.

[1.] In reply to the Query of J. H. G. in regard to Tuckahoo or Indian Bread, I regret not being able to give all the particulars asked for, but the following extract from the Treasury of Botany may be useful:

"Tuckahoo is the Americo-Indian name for a curious tuberous production, which is dug out of the ground in several parts of the United States, and which has been referred by Fries to the genus *Pachyma*. Like *Sclerotium*, however, *Pachyma* has no fruit, and there is some reason to doubt whether it has any pretensions to be classed with *Fungi* at all. It is composed entirely of pectic acid, and it is very probable that it is a peculiar condition of some root, though of what plant has not at present been ascertained. One similar production at least has been found in China, where it is supposed to possess medicinal virtues; and there is reason to believe that another exists there, attaining a diameter of several inches like the American Tuckahoo. As may be supposed from its chemical constitution, it affords a nutritive article of food, for which purpose it is dug up by the natives like the *Mytilia* or Native Bread of Tasmania, with which, however, it does not correspond in character. It is also employed occasionally as a material for making jelly, for which it is well adapted, the pectic acid of currants and other fruits being the principle which disposes their juice when boiled to form a jelly-like mass. The principal objection which is brought forward against the supposed phaenogamous origin of the production is the absence of all trace of vascular or cellular structure like that of phaenogams, or of bark, except such as may be supposed to arise from mere contact with the soil; but the dissimilarity of its structure and that of *Fungi* is quite as great, and the conversion of a fungus into pectic acid would be more surprising."

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GENERAL NOTES.

CURIOUS ELECTRIC PHENOMENON.—At about 4.30 P. M. this day a severe thunder storm with a deluge of rain came up from the north-west, and lasted about an hour. At 5.30 my wife was standing at the window watching the receding storm, which still raged in the south, just over Leicester, when she observed, immediately after a double flash of lightning, what seemed like a falling star, or a fire-ball from a rocket, drop out of the black cloud about 25° above the horizon, and descend perpendicularly until lost behind a belt of trees. The same phenomenon was repeated at least a dozen times in fifteen minutes, the lightning flashes following each other very rapidly, and the thunder consisting of short and sharp reports. After nearly every flash a fire-ball descended. These balls appeared to be about one-fifth or one-sixth the diameter of the full moon, blunt and rounded at the bottom, drawn out into a tail above, and leaving a train of light behind them. Their color was mostly whitish, but one was distinctly pink, and the course of one was sharply zig-zagged. They fell at a rate certainly not greater than that of an ordinary shooting star. I have never witnessed a phenomenon of this kind myself, but my wife is a good observer, and I can vouch for the trustworthiness of her report.

F. T. MOTT.

Bristol Hill, near Leicester, June 22, (Nature).

MM. LE BON and NOEL have extracted from tobacco smoke the following products, which they recently presented to the French academy in three flasks: 1, Prussic acid; 2, an alkaloid of agreeable odor, but as poisonous as nicotine; 3, aromatic principles still undetermined, but contributing, with the alkaloid mentioned, to give tobacco smoke its perfume. The alkaloid in question is thought to be identical with a compound, collidine, the existence of which has been observed in the distillation of various organic substances, but whose physiological and toxical properties have been overlooked.

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